Appendix 5: Slides Presented by Speakers during the Forum

Part One: Slides Presented During Workshops

C. Contaminants in Stocked Fisheries: Potential for contamination, human exposure, and human health risks. Bob Brodberg, State of California, moderator.

1. *PCBs and Hatchery Trout in Pennsylvania—The Good, the Bad and the Ugly!* John Arway, State of Pennsylvania
2. *Regulating Contaminants in Feed for Fish*. Frances Pell, US FDA, Center for Veterinary Medicine

D. The Use of Composite Samples in the Development of Fish Advisories. Razelle Hoffman-Contois, State of Vermont, moderator.

1. *Use of Composited Fish Samples for Assessing Health Risks to High Intake Consumers.*. John Persell, Minnesota Chippewa Tribe, Research Lab
2. *Composite Sampling Analysis of Fish*. Henry D. Kahn, US EPA

E. Addressing Multiple Pollutants in Fish, Eric Frohmberg, State of Maine, Moderator

1. *Addressing Multiple Contaminants in Fish.*. Roseanne Lorenzana, US EPA Region 10
2. *Framework for Cumulative Risk Assessment*. Edward Bender, US EPA

Part Two: Slides Presented During Plenary Sessions

I. Update on Activities Related to the 2001 Forum

A. *New Version of the Risk Communication Guidance.* Barbara Knuth, Cornell University
B. *Update: Relationship of TMDLs to Fish Advisories*. Jim Pendergast, US EPA

II. Reports from the Weekend Sessions

A. *Methylmercury Contamination in Fish: Human Exposures and Case Reports*. Henry A. Anderson, State of Wisconsin
B. *Mercury Advisories*. Amy D. Kyle, University of California Berkeley

III. Advisories for Commercial Fish: Federal, State, and Tribal Approaches. Elaine Krueger, State of Massachusetts, Moderator

A. *Report on the Advisory Panel to the Food and Drug Administration on Mercury Advisories.* H. Vasken Aposhian, University of Arizona.
B. *FDA Consumer Advisory for Methylmercury*. Philip Spiller, US FDA
C. *Sport and Commercial Seafood Wisconsin Integrated Public Health Message: Maximize Health Benefit, Minimize Risk, Coordinate Health Message*. Henry A. Anderson, State of Wisconsin
D. *Context for Connecticut's Seafood Advisory.* Gary Ginsburg, State of Connecticut
E. *Consumer Advisory for Commercial Fish*. Andy Smith, State of Maine.

IV. Hot Topics—Chemicals of Concern. Luanne Williams, State of South Carolina, Moderator

A. Mercury

- *Methylmercury: Ongoing Research on Toxicology*. Kathryn R. Mahaffey, US EPA
- *Setting a Methylmercury Reference Dose (RfD) for Adults*. Alan H. Stern, State of New Jersey

B. Brominated Flame Retardants (Polybrominated Diphenyl Ethers or BDEs)

- *Occurrence of PBDE Flame Retardants in Fish*. Robert C. Hale, Virginia Institute of Marine Science
- *PBDEs: Toxicology and Human Exposure.* Linda S. Birnbaum, US EPA
- *Polybrominated Diphenyl Ethers (BDEs)*. Khizar Wasti, State of Virginia

C. Dioxins and Coplanar PCBs

- *Emerging Science of the Dioxin Reassessment*. Dwain Winters, US EPA

D. Lead

- *Application of the Lead IEUBK Model to Assess Spokane River Fish Consumption Health Risks.* Lon Kissinger, US EPA Region 10.
- *Occurrence of Lead in Fish*. Robert Brodberg, State of California

E. Polycyclic Aromatic Hydrocarbons

- *Polycyclic Aromatic Hydrocarbons (PAHs) in Fish and Invertebrates*. Usha Varanasi, Northwest Fisheries Science Center, National Oceanic and Atmospheric Administration

V. Approaches to State and Tribal Advisories. Jeff Bigler, US EPA, Moderator

A. *Setting Statewide Advisories Based on Upper Percentile Lake Averages.* Eric Frohmberg, State of Maine
B. *Use of Maine's Statewide Advisory in a Tribal Setting*. Susan M. Peterson, Aroostook Band of Micmacs Environmental Laboratory
C. *North Dakota's Fish Consumption Advisory: A Statewide Advisory Based on Average Concentrations.* Mike Ell, State of North Dakota
D. *Advisories in Pennsylvania*. Bob Frey, State of Pennsylvania
E. *Minnesota Statewide Fish Consumption Advice*. Pat McCann, State of Minnesota
F. *Regional Fish Advisory for the Mississippi Delta*. Henry Folmar, State of Mississippi
G. *Consumption Advisories Based on 8 Meals per Month.* Joseph Beaman, State of Maryland

VI. Approaches to Considering Benefits in Advisory Programs. Dan Kusnierz, Penobscot Nation, Moderator

A. *Impacts of Fish Contamination in the Columbia River Basin*. Paul Lumley, Yakima Tribe
B. *Dietary Benefits and Risks in Alaskan Villages*. Sue Unger, Aleutian-Pribilof Islands Association

VII. Current Science on the Benefits of Fish Consumption. Andy Smith, State of Maine, Moderator.

A. *Overview of Benefits of Fish Consumption*. Judy Sheeshka, University of Guelph
B. *Use of Quality-adjusted Life Years to Assess Risks and Benefits of Fish Consumption*. Rafael Ponce, University of Washington

Please note that some speakers did not present slides.

Part One: Slides Presented During Workshops

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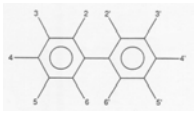
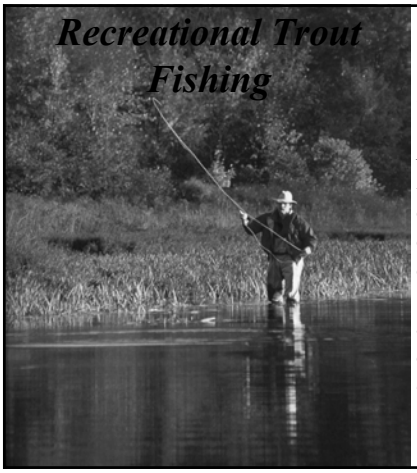
PCBs and Hatchery Trout in Pennsylvania



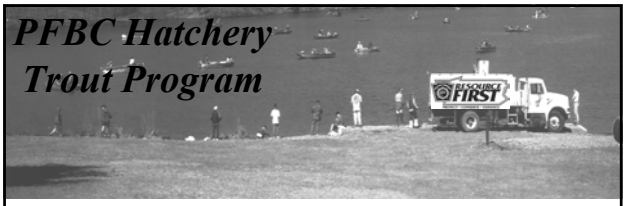
The Good, The Bad and the Ugly!!!

Recreational Trout Fishing

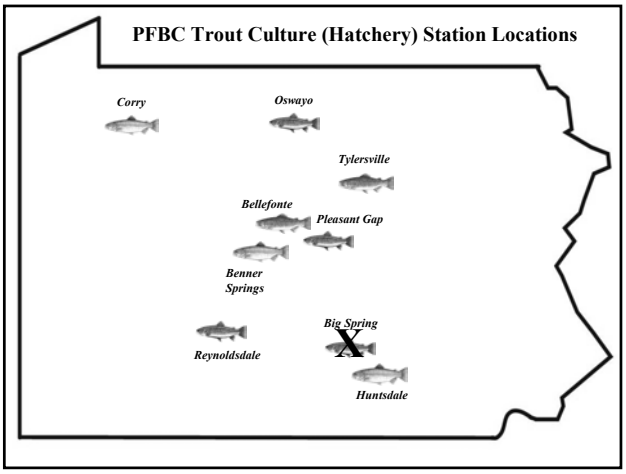


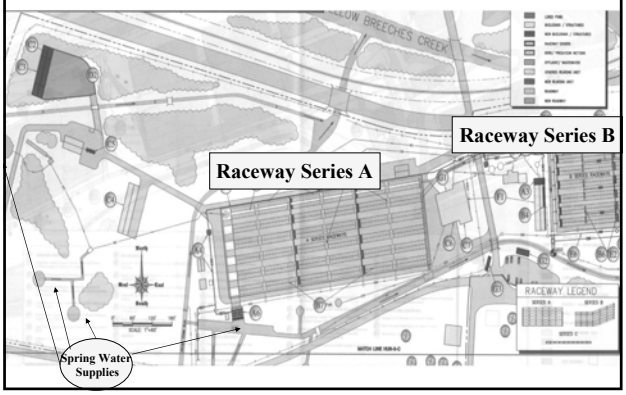
According to a 1996 U.S. Fish and Wildlife Service Report, <u>Trout Fishing in the U.S.</u>, anglers spend more days (8,861,000 days valued at over $568M)) fishing for trout in PA , more any other state except California.

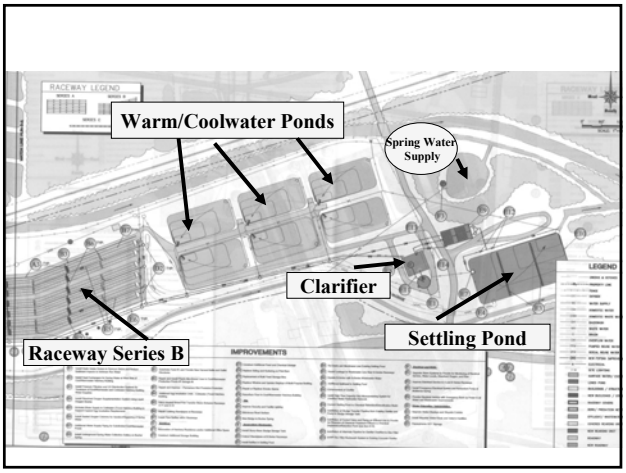
PFBC Hatchery Trout Program



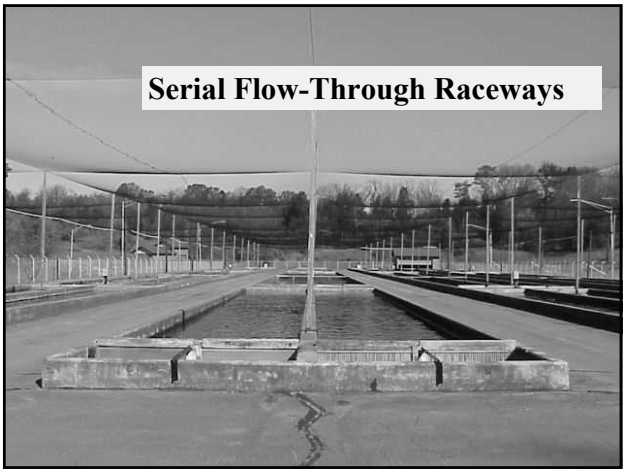
Eight trout hatcheries statewide that produce between 3.8 to 5.2 million catchable trout annually to stock more than 4500 miles of streams.

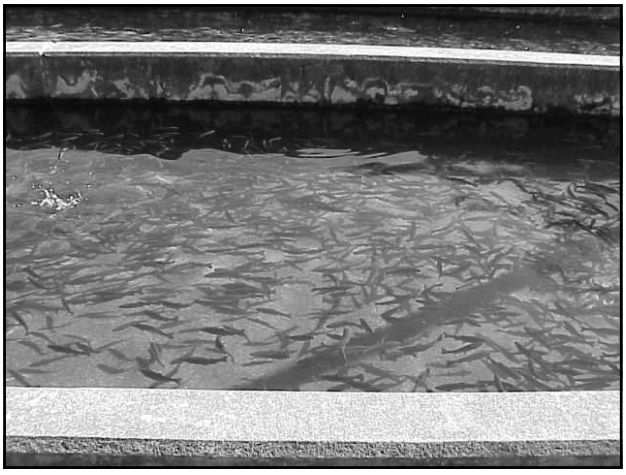


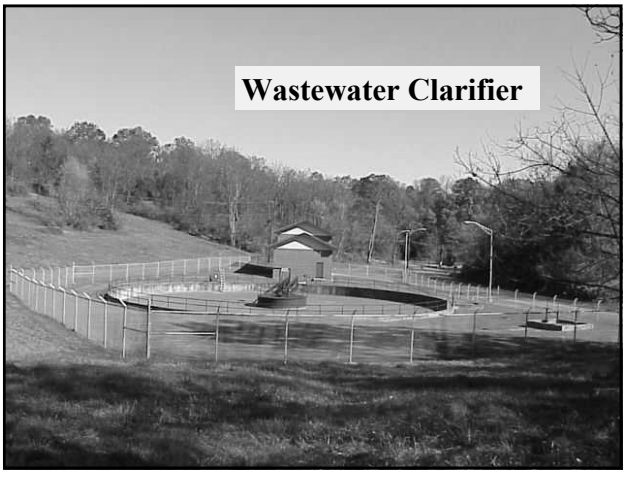


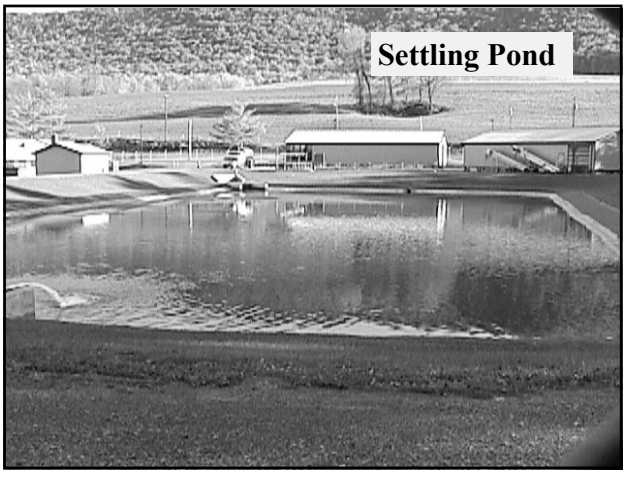

Warm/Coolwater Ponds
Spring Water Supply
Clarifier
Settling Pond
Raceway Series B

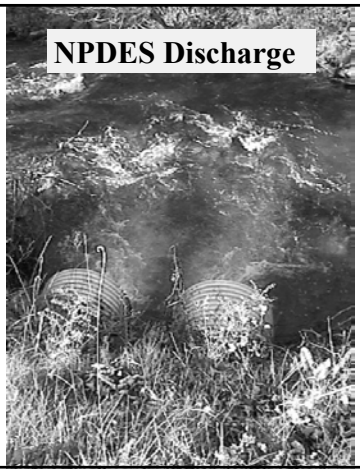

Spring Water Source


Serial Flow-Through Raceways

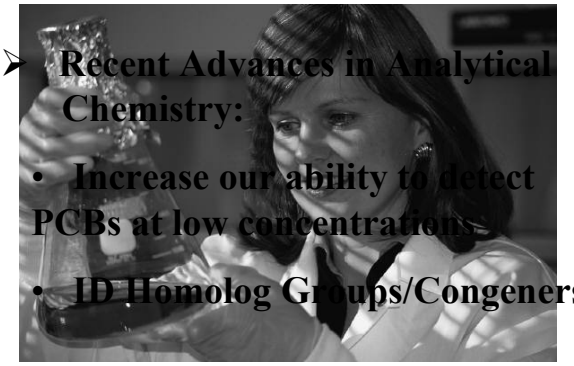



Wastewater Clarifier


Settling Pond



THE GOOD



- Recent Advances in Analytical Chemistry:
  - Increase our ability to detect PCBs at low concentrations
  - ID Homolog Groups/Congeners

THE GOOD

- *PA Tissue/Feed Extraction Protocols for PCBs*
  - Fish Feeds
    - Freeze dry then Accelerated Solvent Extraction (ASE)
    - US EPA Method 3545

THE GOOD

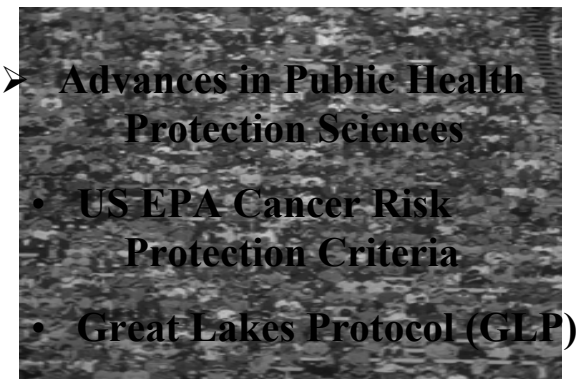
- Fish Tissue
  - Freeze dry then Super Critical Fluid Extraction (SFE) with CO_2
  - Modified US EPA Method 3561

THE GOOD

The PA PCB Analytical Protocol for Fish Tissue and Feeds

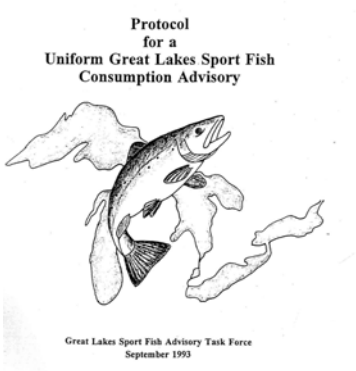
- Gas Chromatography/Electron Capture Detector (GC/ECD) Analysis (US EPA Method 8082)
  - Quantify Aroclors 1221, 1232, 1242, 1248, 1254 and 1260

THE GOOD



- Advances in Public Health Protection Sciences
  - US EPA Cancer Risk Protection Criteria
  - Great Lakes Protocol (GLP)

THE GOOD



The Good

- **Uses a weight-of-evidence approach.**
- **PA began applying this protocol to hatchery-reared trout in 1998.**

THE GOOD

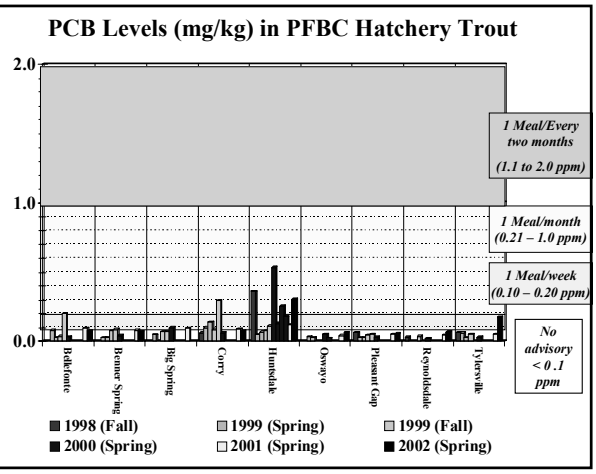
- **Focused on PCBs which is the chemical contaminant most frequently encountered in Great lakes fish.**

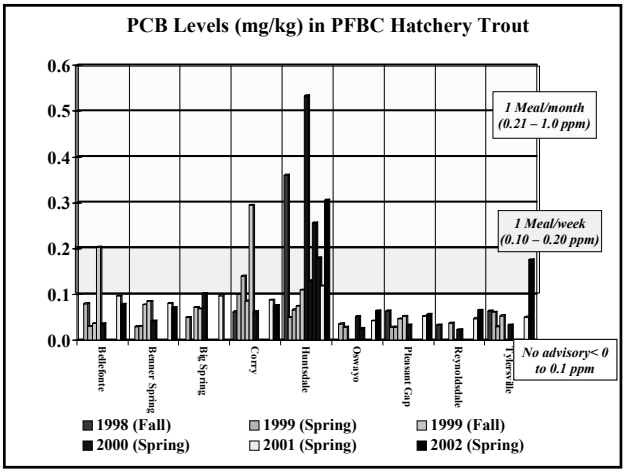
THE GOOD

- **Non-cancer (neurological) endpoint to protect pregnant women and children and women of child-bearing ages.**

Great Lakes Protocol Advisory Groupings (1993)

- **Group 1 (No Advisory): 0 - 0.06 ppm**
- **Group 2 (1 meal/week - 52 meals/year): 0.06 - 0.2 ppm**
- **Group 3 (1 meal/month - 12 meals/year): 0.21 - 1.0 ppm**
- **Group 4 (6 meals/year): 1.1 - 1.9 ppm**
- **Group 5 (No consumption): >1.9 ppm**

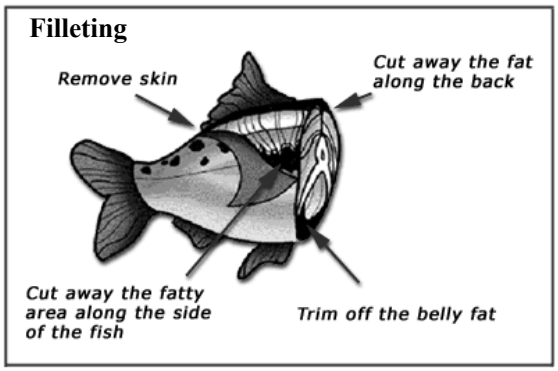




Hatchery Trout Sampling

- (1) 5 Fish Composite
- (5) 8 Fish Composites
  - ✓ UCL (95%) of a one tail test

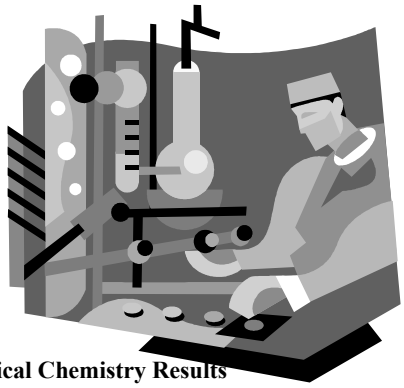
Variables



Variables

Partitioning in Body Tissues

Variables



Analytical Chemistry Results

Fish Feed Component Testing

- Fish Feed Components
  - Fish Oils
    - ✓ Crude
    - ✓ Deodorized
    - ✓ Winterized
  - Fish Meals
    - ✓Feather
    - ✓Soy
    - ✓Cereal
    - ✓Blood
    - ✓Bulk Flour
    - ✓Ground Wheat
    - ✓Soybean
    - ✓Poultry

Fish Feed Testing

- **Fish Feed**
  - **Perdue Specialty Feeds**
  - **Zeigler Brothers**

Fish Feed Component Results

- **Fish Oils**
  - ✓**<0.05 to 0.938**
  - ✓**mean= 0.265**
  - ✓**n=6, 10 tests**
- **Fish Meals**
  - ✓**<0.05 to 0.102**
  - ✓**mean= 0.03**
  - ✓**n=6, 12 tests**
- **Other Ingredients**
  - ✓**<0.05**

Results in mg/kg

Fish Feed Results

- **Fish Feed**
  - **<0.05 to 0.2**
  - **mean= 0.061**
  - **n=24**
  - **44 tests**

Results in mg/kg

PSU Academic Study Objectives

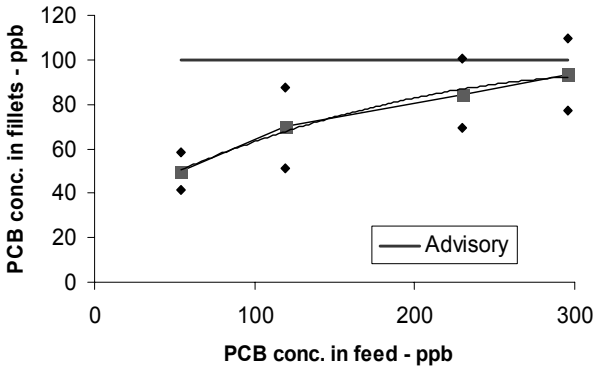
- **ID Possible Sources of PCBs in PFBC Hatchery Trout**
- **Determine Bioaccumulation and Assimilation Rates**

PSU Academic Study Objectives

- **Determine the Relationship between PCB Concentrations in the Feed and in the Hatchery Trout**
- **Determine Seasonal Variations**

Feed Formulations (*PCBs added)

Diet	Fish Meal	Menhaden Oil	PCB (ppb)
1	Herring	Distilled	69
2	Menhaden	Filtered	126
3*	Menhaden	Filtered	220
4*	Menhaden	Filtered	280



PSU Study Results

When feed concentrations are less than 0.126 ppm PCBs, concentrations in trout fillets after 6 months of feeding did not exceed 0.10 ppm (1 meal/week).

THE UGLY

RISK

COMMUNICATION!!!!!

Have I not walked without
an upward look
Of caution under stars that
very well
Might not have missed me when
they shot and fell?
It was a risk I had to take—
and took.

Robert Frost
***Bravado,* 1962**

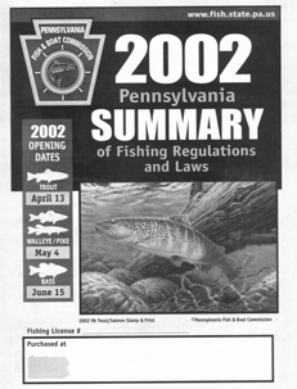
What is Risk?

- **Basically, it is a measure of the severity and probability of harm.**
- **Frost's poem suggests that it is an unavoidable part of our daily lives.**

Public Notice of Fish Advisories

General Statewide News Releases

Public Notice of Fish Advisories



Public Notice of Fish Advisories

On 11 April 2001 PA issued a general statewide advisory that states no person should eat more than one-meal-a-week of sportfish caught in any Commonwealth water.

Public Notice of Hatchery Trout Advisories

- **Subject to the statewide one-meal-a-week advisory plus…**
- **Additional advice on www.fish.state.pa.us**

Public Notice of Hatchery Trout Advisories

Pa. must alert public to dangers from fish, fowl, official says

By BILL McKINNEY
Morning News staff reporter

Erie County's chief aquatic biologist warned a state environmental advisory group that Pennsylvania is not protecting the public from chemicals in lake fish and waterfowl.

Robert Wellington, of the Erie County Health Department, acknowledged there is a price to pay for adequate testing and for publicly attaching health risks to the consumption of fish, but he said the alternative is unthinkable.

"...Not using them (human health risk standards), when we have as much information as we do about potential problems of eating unlimited amounts of certain fish is an un-

one who eats more than five pounds of fish a year.

Second, the FDA went on record years ago that its tolerance level for PCBs was probably not adequate.

Third, an advisory being proposed for use by all eight Great Lake states uses criteria for PCB risks that are 100 times more strict than Pennsylvania is now using.

Wellington said Arthur Davis, former secretary of the then Department of Environmental Resources, agreed in early 1993 that Pennsylvania would implement the proposed cautions along with the other Great Lakes states.

Since then, Wellington said, the states have not all agreed on

promised his help.

In other testimony before the council, elected officials from Jefferson County and Jefferson County municipalities complained that DEP has been ignoring the very Solid Waste Plan it ordered their county to prepare.

Worse, they said, DEP officials were publicly siding with applicants for new landfills, to the point the state officials defended the applicants at meetings and made it unnecessary for them to personally testify.

Jefferson County Commissioner Donald R. Hillard said his county's

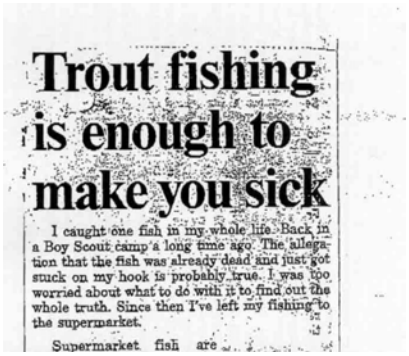
Hillard said it is myth to think permits will not be issued as long as they are consistent with county plans, that permits will not be issued if they interfere with county plans and that the DEP will act in a fair and independent manner when evaluating permit applications. He said the opposite is true.

"The county is left out of the decision making process. The county has no say as to the consistency of proposed facilities with other long-term plans, goals and objectives," he said.

David Steele, vice-chairman of the Jefferson County Solid Waste Authority, said

ERIE, PA., MORNING NEWS, Wednesday, Septembe

Public Notice of Hatchery Trout Advisories

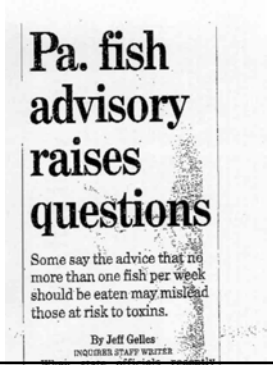


Trout fishing is enough to make you sick

I caught one fish in my whole life. Back in a Boy Scout camp a long time ago. The allegation that the fish was already dead and just got stuck on my hook is probably true. I was too worried about what to do with it to find out the whole truth. Since then I've left my fishing to the supermarket.

Supermarket fish are

Public Notice of Hatchery Trout Advisories



Pa. fish advisory raises questions

Some say the advice that no more than one fish per week should be eaten may mislead those at risk to toxins.

By Jeff Gelles
INQUIRER STAFF WRITER

Public Notice of Hatchery Trout Advisories

NEWS

Fish flap warrants investigation, say Democrats

By GEORGE STRAWLEY
The Associated Press

HARRISBURG — House Democratic leaders demanded that Gov. Tom Ridge's administration investigate problems surrounding the issuance of a health advisory warning Pennsylvania anglers about chemical contamination in the state's sport fish.

Environmental Protection advised people not to eat more than one meal of fish from Pennsylvania waters in a week as a precaution against mercury contamination.

When the mercury warning was issued, DEP officials from the Republican administration acknowledged "problems and difficulties" with the PCB tests performed by a private

up a better system to protect the lives of Pennsylvania and the resources in this state."

Vern, who suggested Gak withhold ing information on test results could be "downright criminal," called for an internal investigation by acting DEP Secretary Dave Hess as well as an outside review by the office of Democratic Auditor General Robert P. Casey Jr. A

get the public the health information they need."

A spokesman for the Fish and Boat Commission stood by his earlier characterization of the dispute as a case of two organizations reading different conclusions with the same results.

"There seems to be fundamental confusion as to what the consumption advisory really means," said the

handling of fish histories in the past. Earlier in the day, biologist Eugene P. Mac Lib provided to The Associated Press a copy of a March 7 report in which a DEP biologist recommended an advisory for the species based on test results. Attempts to obtain a copy directly from DEP were not immediately successful Friday.

A DEP spokeswoman said last date

Public Notice of Hatchery Trout Advisories

Legislators rebuke fish commission

Public advisories on safe consumption amounts are confusing, they say.

BY ELLEN LYON
OF THE PATRIOT-NEWS

While state Fish and Boat

in the United States since 1977 because they are suspected of causing cancer, they persist in the environment.

In April, three days before trout fishing season opened, DEP advised people, especially pregnant and nursing mothers, women of child-bearing age and

Public Notice of Hatchery Trout Advisories

PRINTER'S NO. 3536

THE GENERAL ASSEMBLY OF PENNSYLVANIA

HOUSE RESOLUTION

No. 500 Session of 2000

INTRODUCED BY B. SMITH, CAWLEY, FORCIER, BENNINGHOFF, STABACK AND SURRA, MAY 11, 2000

REFERRED TO COMMITTEE ON RULES, MAY 11, 2000

A RESOLUTION

1 Urging the Pennsylvania Fish and Boat Commission to have studies
2 conducted concerning chemicals in its hatchery trout.

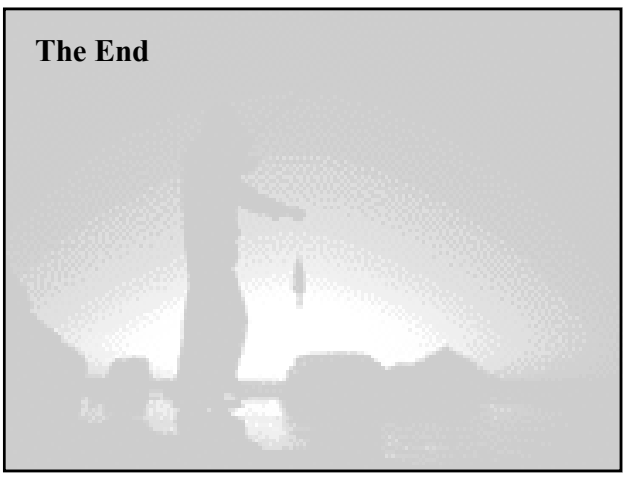
COMMONWEALTH OF PENNSYLVANIA
PENNSYLVANIA FISH AND BOAT COMMISSION
NOVEMBER 1999

FISH CONSUMPTION ADVISORY

DO NOT EAT TROUT TAKEN FROM THESE WATERS

THE PENNSYLVANIA FISH AND BOAT COMMISSI
IAS ISSUED AN INTERIM CONSUMPTION STATEM

The End



Regulating Contaminants in Feed for Fish

Fran Pell
Consumer Safety Officer
Division of Compliance
Center for Veterinary Medicine
Food and Drug Administration

The Food and Drug Administration (FDA) has the responsibility to enforce the Federal Food, Drug, and Cosmetic Act (the Act) by ensuring that foods for man and animal are safe and free of residues of illegal contaminants.

'Food' means

(1) articles used for food or drink for man or other animals

(2) chewing gum, and

(3) articles used for components of any such article

The FDA's, Center for Veterinary Medicine (CVM) is responsible:

- **for protecting the animal feed supply**
- **assuring that it is safe and wholesome,**
- **that incidence of harmful residues in human food derived from animals is minimized.**

The Center uses Compliance Programs to give guidance to the Field on how we want our programs implemented by the Field.

The Feed Contaminants Compliance Program is designed to address the Center's responsibility for feed contaminants.

Animal feeds adulterated with pesticides, industrial chemicals, mycotoxins, and other microbiological agents may present a hazard:

- to livestock health and production,
- the nation's food supply,
- and to the public health by the residues which may occur in animal derived foods

The more frequently identified contaminants in animal feeds are toxic, carcinogenic, mutagenic, teratogenic, or otherwise deleterious to animal and human health.

The Feed Contaminants Compliance Program provides guidance for:

- Investigation of the cause(s) of violative sample findings and Contamination Response System (CRS) reports.

The CRS is an early warning system developed by the United States Department of Agriculture (USDA), Food Safety and Inspection Service (FSIS) for the reporting of tissue contaminants.

The Feed Contaminants Compliance Program provides guidance for:

- Collection and analysis of animal feed samples for pesticides, industrial chemicals, heavy metals, mycotoxins and microbiological agents.
- Surveillance of the industry to identify potential problem areas to be addressed under this program.

The Feed Contaminant program is:

- A cooperative program ☮
  - Our Field (investigators, compliance officers and analysts)
  - State counterparts could also collect samples for FDA
  - Center will issue directed assignments

- District's program monitor ☑
  - Drafts regional pesticide plan
  - Includes sampling for contaminants in human foods
  - Encouraged to work with the states

SCOPE OF THE COMPLIANCE PROGRAM

- Pesticide and industrial chemical samples assigned under this program are to be incorporated into the each FDA Regional Pesticide Sampling Plans.
- Guidance on developing FDA/State cooperative sampling plans.

SCOPE OF THE COMPLIANCE PROGRAM CONT'D

- More definitive guidance on priority feeds and feed ingredients which the Center has identified as high-risk commodities.
- Regional evaluations and headquarters review to determine the need for making adjustments to sampling plans.

- The Center will issue directed assignments as necessary.
- These directed assignments with the District's surveillance are expected to provide contaminants-related data.

- This will supplement the data from such sources as United States Department of Agriculture (USDA), Environment Protection Agency (EPA) and industry.

Example of directed assignment:

- Since fiscal year 2000, CVM issued sampling assignments to test for Dioxin.
- There were 50 samples collected for each assignment.
- Sampling a tiered approach

- Criteria for sampling
  - Past history of dioxin contamination
  - Likelihood ingredient will be used in a ration
  - Amount typically used in a ration
  - Amount of fat

- First tier ->
  - Feed suspect containing highest dioxin
    - Fish meal, oilseed, deodorizer distillates, animal fat and meat and bone meal
    - Ingredients where air deposition (corn)
    - Uptake from soil (beet molasses)
    - Fire during harvest (cane molasses)

- Fish meals sampled as part of the assignment

  - Catfish and anchovy (used for pet food)
  - Pacific species (pollock)
  - Menhaden (90% of fishmeal in U.S.)

- Second tier
  - Feed ingredients 2nd likelihood of elevated dioxin level
    - Oilseed meals
    - Fat-soluable vitamins
    - Complete Feeds
    - Milk Products
    - Minerals
    - Wood Products

- Third tier
  - Feed ingredients 3rd likelihood of elevated dioxin level
    - Sampling similar to previous assignment

Web site:

www.fda.gov/cvm

The End

Questions????

Email: fpell@cvm.fda.gov

USE of COMPOSITED FISH SAMPLES for ESTIMATING HEALTH RISKS to HIGH INTAKE CONSUMERS

John Persell
Minnesota Chippewa Tribe
Research Lab

Consider Two Factors

- Composited Fish
- Bolus Dosing

Types of Fish Composites

- Batch: Homogenize fish together (greater variance about the mean)
- Individual: Homogenize individual fish separately, take equal portions of individual homogenates and homogenize for composite

Composite Variance

- …"even under ideal conditions, the variance of the mean estimated from a set of composite samples underestimates the variance among fish." (Fabrizio, 1995)

Variance Larger in Contaminated Areas

- Fish move in and out of contaminated areas
- Fish have different metabolic rates
- Time of year sampled

Data from Fabrizio Study

- 195 Striped Bass
- Total PCBs in Muscle
- Range = 0.1 to 40.7 ppm
- Average = 3.57 ppm
- Variance = 24.105

The Perfect Homogenate

- Even with composited water samples, there may be difficulty in detecting the presence and severity of extreme concentrations (Fabrizio, 1995)
- Greater difficulty yet with fish homogenates
- Tendency to dilute out hot fish
- Wide range in whole fish homogenates

Bolus Dose

- A potentially large, intermittent dose
- May not be problematic for low intake consumers, however it is a concern for the most susceptible in high intake consumers
- The bolus dose has not been evaluated in most toxicity studies (EPA, 2000)

Those Most Susceptible

- Children: including fetuses and breast fed children; for fetuses, the timing of fetal exposure is at least as important as the dose
- Elderly: diminished detoxification capacities
- Persons taking pharmaceuticals

High Intake Fish Consumers

- Individuals, such as Tribal members utilizing traditional lifeways, are more exposed in general to fish contaminants. Intake ranges up to one pound per day (454 grams/day) in the Pacific Northwest; higher intakes have been reported for Alaska Tribes
- These high intake consumers are more exposed to bolus doses from highly contaminated fish

Recommendation

- When using composited fish homogenates to determine safe fish consumption quantities for high intake consumers, employ an additional safety factor of 3 to 10
- Use specific chemical toxicity as a safety factor metric
- This will offer a reasonable accounting of the inherent contaminant underestimates

Literature Cited

- Fabrzio, M.C., Frank, A.M., and Savino, J.F. Procedures for Formation of Composite Samples from Segmented Populations. Environ. Sci. Technol. 1995. 29: 1377-44.
- USEPA. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Vol. 2, 3rd Ed., EPA 823-B-00-008

Composite Sampling Analysis of Fish

Henry D. Kahn
Statistics & Analytical Support Branch
Engineering & Analysis Division
Office of Science and Technology
Office of Water
US Environmental Protection Agency

Composite Sampling Analysis of Fish

- Introduction
- Basics of Composite Sampling
- Examples: Analysis of Blood and Fish Tissue
- Assessment of the Effectiveness of Composite Sampling Analysis: Flounder Data
- Number of Fish in the Composite: Maine lakes Study
- Conclusions

Introduction

- Composite sampling is used widely in environmental and other applications.
  - Soil, water, solid waste, hazardous material
  - Biomedical, e.g., blood, pharmaceuticals
  - Manufacturing quality control,e.g., liquids, bulk materials

Introduction

- Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Vol. 1, Fish Sampling and Analysis, 3rd Edition, EPA 823-B-00-007, Nov 2000.
  - "Composite samples of fish fillets or of the edible portions of shell fish are recommended for analysis of target analytes in screening studies."
  - "Composite samples are homogeneous mixtures of samples from two or more individual organisms of the same species collected at a particular site and analyzed as a single sample."

Introduction

- Composite Sampling Analysis of Fish
  - A cost effective method for estimating mean contaminant levels in fish tissue
  - Provides sufficient amount (usually) of fish tissue for analyses
  - Does not provide information on individual fish

Basics of Composite Sampling

- Composite sample: collect a number of sample units and combine them (mix, blend, homogenize) into a new sample, i.e. the 'composite'. One or more measurements are made on the composite.
- Composite sampling supports inference regarding key population parameters (e.g., the mean) in a cost effective manner.
- Composite sampling does not provide information on individual sample units.

Basics of Composite Sampling

- Fundamental Concept: A composite sample is a mixture of individual sample units. Mixing results in physical averaging of individual units.
- Composite sampling is useful when:
  - Cost of analyzing individual samples is high
  - Cost of obtaining individual samples is relatively low
  - Samples can be thoroughly mixed
  - Study budgets are limited

Basics of Composite Sampling

Composite sampling objectives:

- **Objective is to estimate mean concentrations or presence/absence**
- **Information on individual sample units is not a priority**

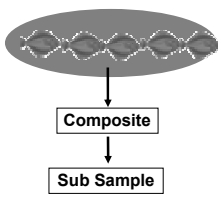
Example: Analysis of Blood Samples - Presence / Absence

- Composite Sample analysis in World War II
  - Large numbers of blood samples were analyzed for syphilis
  - Composite samples were formed from batches of individual samples
  - If composite tested positive, all individuals in the composite were retested separately
  - If a composite tested negative, all individuals in the composite were cleared

Example: Analysis of Blood Samples - Presence / Absence

- Methodology documented in a famous paper by Dorfman (1943) "The Detection of Defective Members of Large Populations"
  - batch size was optimized based on likelihood of syphilis and cost of analysis
  - inference regarding individuals using composites is possible but individual sample material is required

Example: Composite Analysis of Fish - Physical Averaging to Obtain Mean Estimate



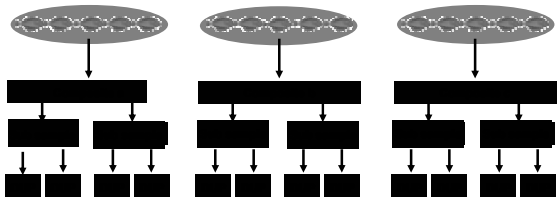
Measured concentration of Sub Sample = estimated mean of individual units

Assessment of the effectiveness of composite sampling

- It is typical in practice to make only one measurement on the sub sample
- The one measurement is adequate for estimating the mean of the individual units
- Additional sampling and analysis is required to obtain information on sub sampling and repeat measurement variability that will support the assessment of composite sampling

Assessment of the Effectiveness of Composite Sampling: Flounder Data

Conduct 15 Individual Analysis



Total number of samples for analysis = 27 (15 individuals + 12 dupes)

Statistical Analysis of Flounder Samples

	Individual Fish				
	Minimum Concentration	Maximum Concentration	Mean Concentration	95% CI for Mean Concentration[a]	Composite Concentration
PCB 118 (ng/kg)					
Composite a	254	349	305	[259 - 376]	298
Composite b	271	426	308	[251 - 410]	295
Composite c	331	437	385	[332 - 465]	369
Overall	254	437	333	[302 - 372]	321
Methyl Hg (ug/kg)					
Composite a	9.0	47	22	[12 - 110]	22
Composite b	8.4	37	23	[13 - 182]	23
Composite c	16	32	24	[17 - 46]	20
Overall	8.4	47	23	[17 - 35]	22

[a] Based on mean of log-normal distribution (CI method by Land [1972])
CI = Confidence Interval

Statistical Analysis of Flounder Samples

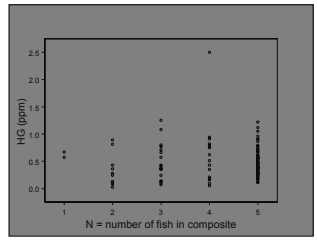
- Statistical comparisons do not show evidence of difference between composite and individual concentrations ($\alpha = 0.05$)
- The composite measurements provide good approximations to the *average* individual concentrations (i.e., the overall mean)
- Composite samples should be adequate for risk assessment
  - Costs are substantially less than for analysis of individual fish

Methyl Hg: Sub Sample / Duplicate Analysis

Number of Fish in the Composite

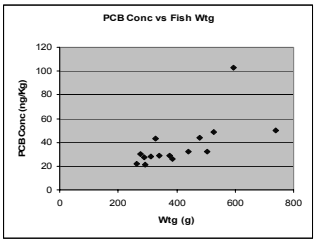
- Protocols for composite analysis specify a number of fish to be included in the composite
- In field studies it often is not possible to obtain the specified number of fish for each composite
  - This is usually not a significant problem
- Typically, the size of the fish in the composite is more important
  - Composites should be comprised of similar size fish since tissue concentration for many contaminants is correlated with size

Composite HG Concentration vs Number of Fish in the Composite



Data: *Fish Tissue Contamination in Maine Lakes*, State of Maine DEP (1997) from "Are the Fish Safe to Eat? Assessing Mercury Levels in Fish in Maine Lakes" by J. Hoeting & A. Olsen in Statistical Case Studies by Peck, Haugh, Goodman (1998)

PCB Concentration vs Fish Weight



Conclusions

- Composite sampling analysis of fish is effective
  - Theory, experimental results support this
  - Objectives for the analysis must be clear
- Protocols for sampling and analysis should be adhered to strictly
  - Number of fish in composite may vary without severely affecting results
  - Size of fish in composite is more likely to a critical factor

Conclusions

- Sub sampling and replicate analyses should be performed on, at least, a subset of samples
  - Important as a check on the effectiveness of composite analysis and chemical analysis
- Refer to Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Vol. 1, Fish Sampling and Analysis, 3rd Edition, EPA 823-B-00-007, Nov 2000.

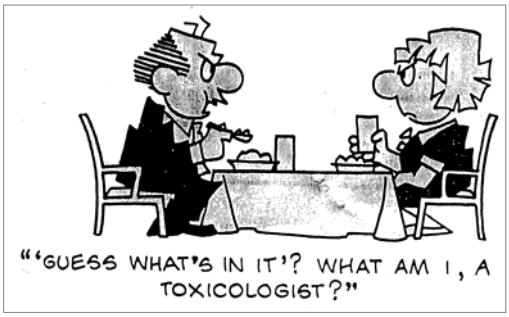
Addressing Multiple Contaminants in Fish

AFS/EPA National Forum on Contaminants in Fish

October 20, 2002

Dr. Roseanne Lorenzana

Multiple contaminants . . . .



U.S. EPA Guidance

- Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Vol. 2, Risk Assessment and Fish Consumption Limits (3rd edition, EPA 823-B-00-008, Nov 2000).

Available on EPA website ...

http://www.epa.gov/waterscience/fish/guidance.html

U.S. EPA Guidance

- Supplementary Guidance for Conducting Health Risk Assessment for Chemical Mixtures (EPA 630/R-00/002, August 2000).

Available on EPA website ...

http://www.epa.gov/ncea/raf/chem_mix.htm

Guidance for Fish Advisories, Vol 2, Risk Assessment and . . .

- Section 3.5
- Equation 3-13
  - Cancer

$$CR_{lim} = \frac{ARL \bullet BW}{\sum_{m=1}^{x}\left(\sum_{j=1}^{n} C_{mj} \bullet P_j\right) \bullet CSF} \qquad (3\text{-}13)$$

- Equation 3-16
  - Non-Cancer

$$CR_{lim} = \sum_{m=1}^{x}\left(\frac{RfD_m \bullet P_m}{C_m}\right) \bullet BW \qquad (3\text{-}16)$$

Fish Intake Rate Decreases . . .

$$CR_{lim} = \sum_{m=1}^{x}\left(\frac{RfD_m \bullet P_m}{C_m}\right) \bullet BW$$

Another example of this approach ...

"Fish Consumption Advisories: Toward a Unified, Scientifically Credible Approach", Dourson and Clark, Regulatory Toxicology and Pharmacology 12:161-178.

Paradigm for Mixtures

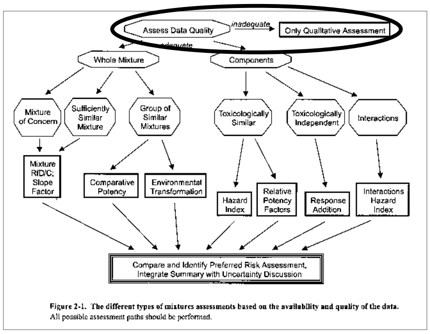
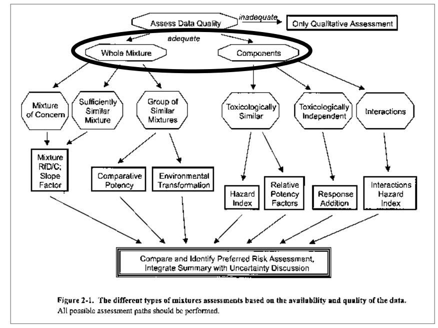


Figure 2-1. The different types of mixtures assessments based on the availability and quality of the data. All possible assessment paths should be performed.

Paradigm for Mixtures



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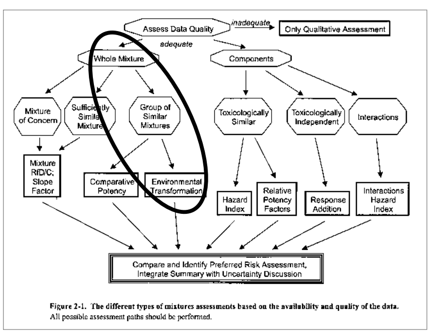
Paradigm for Mixtures



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Paradigm for Mixtures

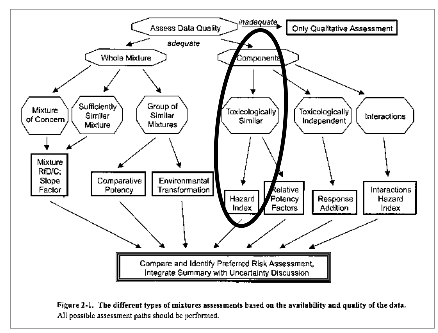


Figure 2-1. The different types of mixtures assessments based on the availability and quality of the data. All possible assessment paths should be performed.

Toxicologically Similar: Dose-Addition

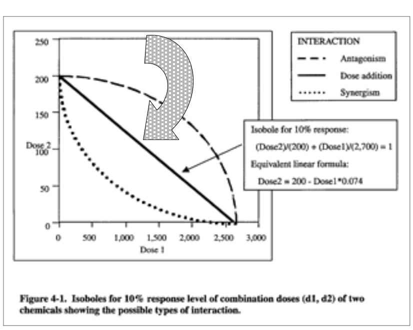


Figure 4-1. Isoboles for 10% response level of combination doses (d1, d2) of two chemicals showing the possible types of interaction.

Dose-Addition (cont'd)

- Hazard Index
- Relative Potency Factor
- Toxicity Equivalence Factor

Dose-Addition (cont'd)

- Hazard Index
  - More generally applicable, but more uncertainty
  - Assumes same "mode of action" and similarly shaped dose-response
  - Limitation: Exposures should be relatively low
  - Scaling factors should be related to each component's toxicity

Dose-Addition (cont'd)

- Relative Potency Factor (RFP)
  - Addition of scaled concentrations.
  - Expert judgment required.
  - Example: B2 PAHs are scaled to B(a)P
- Toxicity Equivalence Factor (TEF)
  - Specific type of RPF.
  - TEFs for dioxin congeners

Paradigm for Mixtures (cont'd)

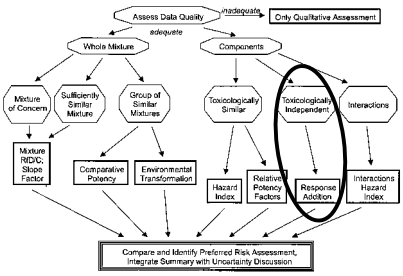


Figure 2-1. The different types of mixtures assessments based on the availability and quality of the data. All possible assessment paths should be performed.

Paradigm for Mixtures (cont'd)

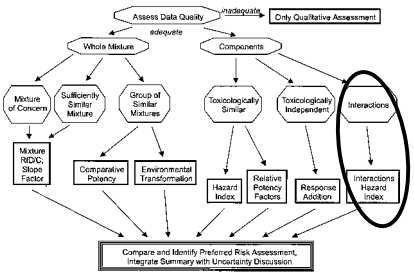


Figure 2-1. The different types of mixtures assessments based on the availability and quality of the data. All possible assessment paths should be performed.

Paradigm for Mixtures (cont'd)

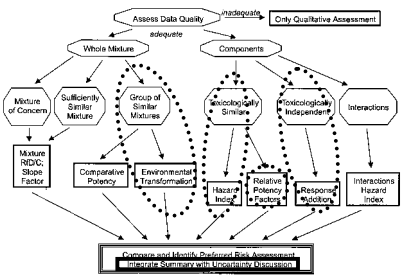


Figure 2-1. The different types of mixtures assessments based on the availability and quality of the data. All possible assessment paths should be performed.

Dose-Addition for other effects

Table 4-1. Example application of the target-organ toxicity dose

Chemical	Hepatic TTD	Renal TTD	Reproductive TTD	Oral exposure (mg/kg per day)	RfD (mg/kg per day)	HQ	Critical effect
Acetone	1.00E-01 RfD	1.00E-01 RfD	NA	4.E-02	1.E-01	0.40	Renal, hepatic
Chloroform	1.E-02 RfD	1.E-01 TTD	NA	5.E-03	1.E-02	0.50	Hepatic
Dibutyl phthalate	NA	NA	2.E-01 TTD	8.E-02	1.E-01	0.80	Incr. mortality
Diethyl phthalate	NA	NA	5.E+00 TTD	1.E+00	8.E-01	1.25	Growth
Di(2-ethyl-hexyl) phthalate	2.E-02 RfD	2.E-02 RS	5.E-02 TTD	1.E-02	2.E-02	0.60	Hepatic
Phenol	NA	2.E+00 TTD	NA	3.E-01	6.E-01	0.50	Developmental
HI-RfD	1.5	2.0	1.3				
HI-TTD	1.5	1.2	0.8				

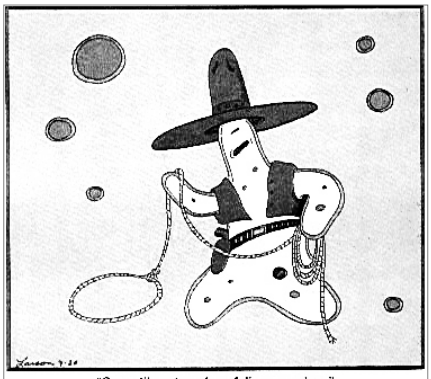
In the TTD columns, the source of the value is coded as:
TTD: new TTD developed for this effect.
RfD: this is the critical effect, so the TTD=RfD.
RS: insufficient data for a TTD, so RfD used as a surrogate.
TTDs and RfDs are from Mumtaz et al. (1997). Exposure levels (dose) are set for illustration only.

Uncertainties

- Data Quality.
- Quality of Health Effects Data.
- Information on Interactions.

For more information . . .

Consult "User Fact Sheets" in the Supplemental Guidance for Conduction Health Risk Assessment of Chemical Mixtures for summary of uncertainties associated with each approach.



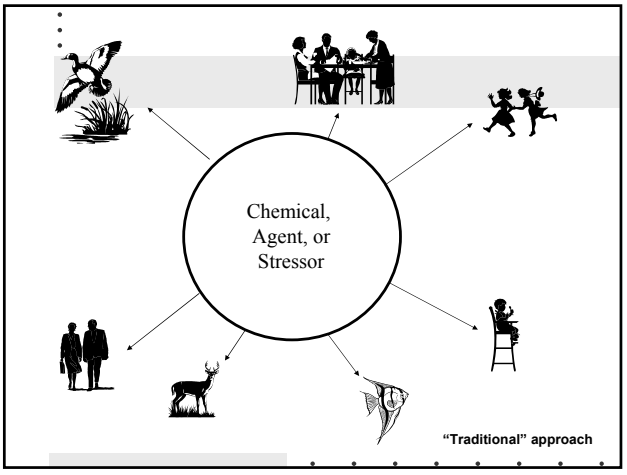
"So, until next week — Adios, amoebas."

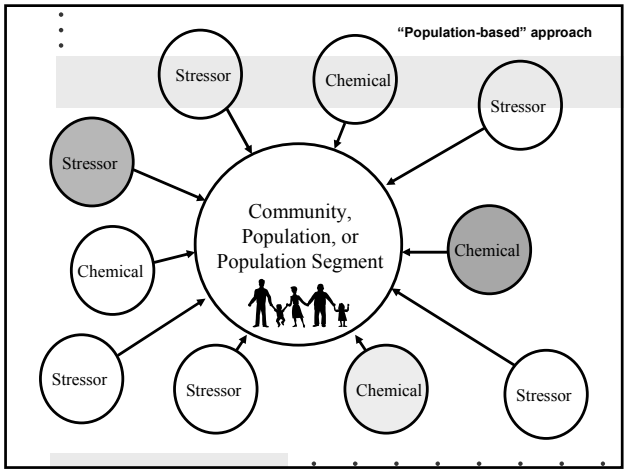
Framework for Cumulative Risk Assessment

Edward Bender ORD
EPA Risk Assessment Forum Technical Panel on Cumulative Risk Assessment

Cumulative Risk Assessment

- "Traditional" Risk Assessment:
  - Where we've been
- Cumulative Risk Assessment (CRA):
  - Why change?
- Framework: What is CRA?
- Guidelines: How do we do CRA?
- How the Framework relates to Fish Advisories ?





Framework vs. Guidelines

- Framework: General description of the topic. An **information document** laying out scope of the subject and how various parts fit together.
- Guidelines: Description of how it's done, including **boundaries** (e.g., limits of "good science") not to be exceeded.

Types of Issues

- Process issues: Extent of public participation, Role of risk managers, etc.
- Technical/scientific issues: Feasibility of certain components, Assumptions and defaults, etc.
- Policy issues: Requirements, etc. (will not be discussed)

Working Definition

- **Cumulative risk assessment:** The examination of the *accumulation* over time (across sources, across routes, etc.) of stressors or exposures that can cause adverse effects, and then the *integration* of the effects these stressors or exposures cause into an estimate and characterization of the risk caused to the individual or population by the stressors *acting together.*

Organization of Framework

1. Introduction
2. Planning, Scoping, and Problem Formulation Phase
3. Analysis Phase
4. Interpretation Phase
5. Glossary
6. References

Where are we going?

- Finish Framework document this year
- Examine case studies and issues for tools and methods through 2004
- Then begin Guidelines work
- http://www.epa.gov/ncea/raf/pdfs/frmwrk_for_cra/Draft_Framework_April23_2002.pdf

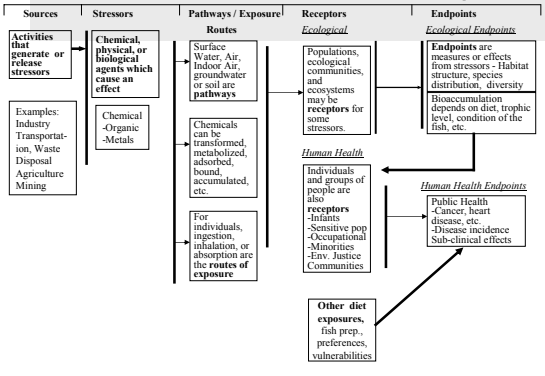
Applying the Framework to Fish Advisories

- Planning and scoping.
  - Problem-Fish are or may be contaminated with one or more chemicals. How do we protect the public?
  - What do we know about stakeholders, sources, exposures and adverse effects?

Conceptual Model

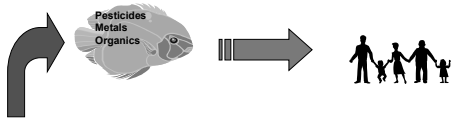
- Defines the goals and assessment context
- Tool for learning, communicating, and consensus building
- Describes linkages among sources, stress, and entities at risk.

A Generalized Conceptual Model with Bioaccumulation and Fish Consumption



Are they contaminated?

How and What?



Who is exposed?

Sources
-Agriculture
-Mining
-Discharge

Analysis Plan for the Assessment

- Describes agreements on data sources, models, quality, and methods
- Carries forward assumptions, rationale for scope, stakeholder values and risk management objectives.
- Helps the analysis inform risk management option selection

Fish Hazard Screen

	Pesticides (4)	Metals (2)	Organics (3)
Sources	Agriculture	Mining	Industrial
Pathways	Direct-fish	Trans-Fish	Direct-Fish
Human Route	Fish Ingestion	Fish Ingestion	Fish Ingestion
	Water	Water	Water
	Food	Food	
Possible Effects	Neurotoxic	Kidney function	Cancers

Exposure and Stakeholders

How often do they eat fish?
What part of the fish do they Eat?
Do they drink water from The sites of concern? Etc.

Health status of stakeholders
-Pre-existing disease?
-Other exposures?
-Dietary habits?
-Lifestyle?
-Health care? …

Concerns of stakeholders
-other unidentified contaminants?
-safety of fish supply?
-costs of risk management?
-scientific uncertainty?

Technical issues

Vulnerability

- Susceptibility/Sensitivity
- Differential exposure
- Differential preparedness
- Differential ability to recover

- Question: How do these factors change risk?

Analysis Phase

- Collect and evaluate data to address the problem
- Fish Advisories may be for :
  - Public notice
  - Part of Remediation, or perhaps
  - To monitor effectiveness of Risk Management actions

Stressors Acting Together

- Combination toxicology- common mech.
- Combining risks-occupational ex.
- Risk factor approach-Heart Disease, RSC
- Biomarkers or biomonitoring
- QALYs, DALYs, LLEs and other

Combining different risks

- Can different types of risk be combined?
- Common metric approach
- Index approach

Uncertainty

- Few good examples of uncertainty analysis for Cumulative Risk Assessments
- New GIS-based technology poses new challenges in uncertainty analysis
- What type of analysis would be useful to a decision-maker?

Risk Characterization

- Draws on scoping and problem formulation
- Do data validate model assumptions (stressors, sources, etc.)
- How are susceptibilities/exposures of fish consumers considered in the CRA
- How does the Fish Advisory help consumers manage risks?

CRA May Apply to Fish Advisories

- To Clarify the Problem and ID Stakeholders
- To Plan Analysis and Monitoring
- To Place Fish Contamination risks in a larger context
- To Help the Public Understand and Manage Risks